# *The Henderson Mine as an Underground Laboratory*

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# *The Henderson Mine as an Underground Laboratory*

- Physics motivations for the lab
- The Henderson Mine
  - Location, history, existing facilities
- Proposed laboratory construction
- Scientific opportunities
- Organization and workshop schedule

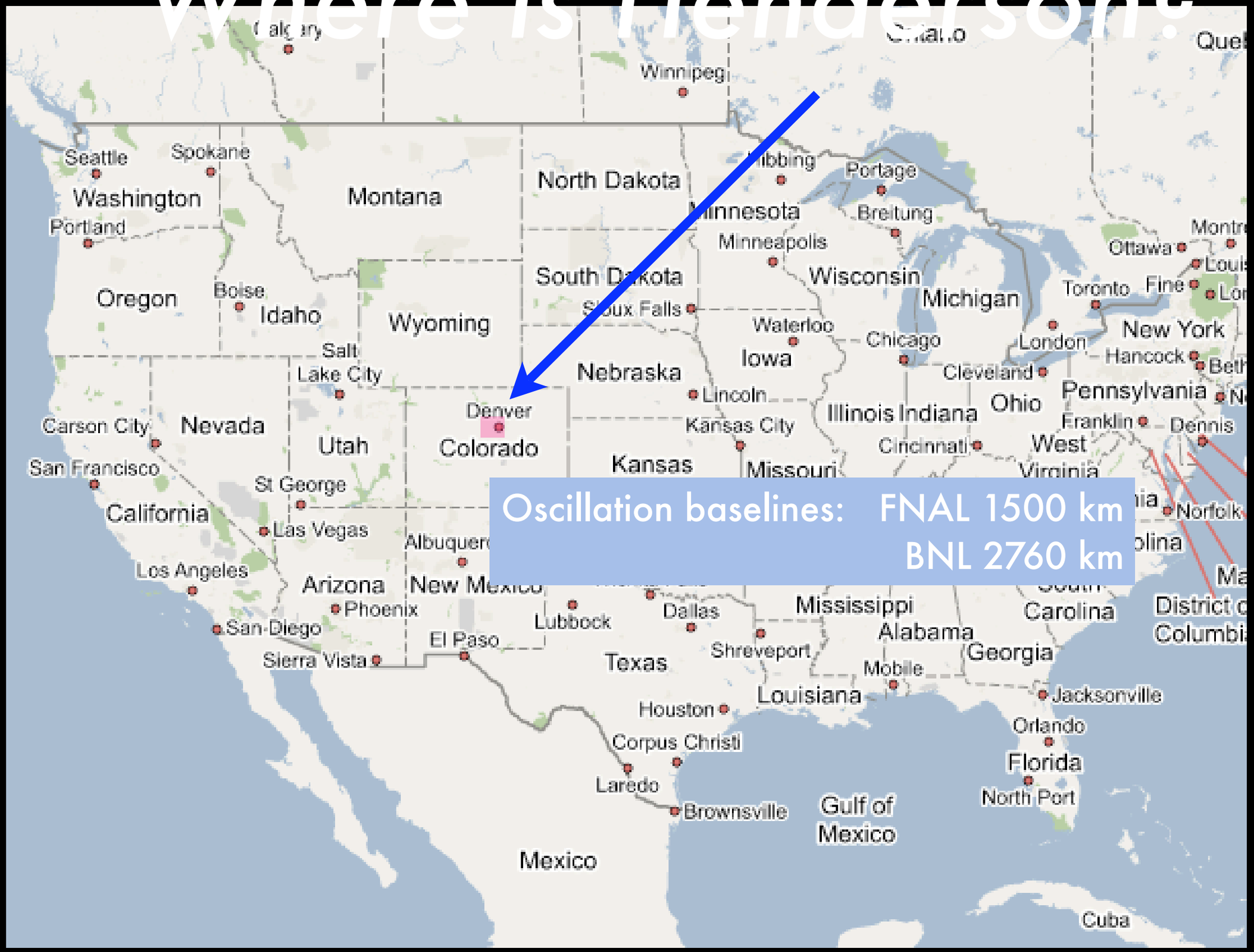
# *Physics motivations*

- Neutrinoless double beta decay: probe of absolute mass scale and Majorana nature of neutrinos
- Direct detection of dark matter
- Complete our exploration of neutrino mass hierarchy and mixing matrix, including CP violation: long baseline and atmospheric neutrinos
- Proton decay
- Low-energy solar neutrino astrophysics
- Low background counting/radioassay
- …and more

# *The Henderson Mine*

- High-volume mine on world's second largest known molybdenum deposit
- Owned and operated by Climax Molybdenum Co., subsidiary of Phelps Dodge
- Mine was built in the 1970s, extensively modernized in late 1990s.

# Where is Henderson?



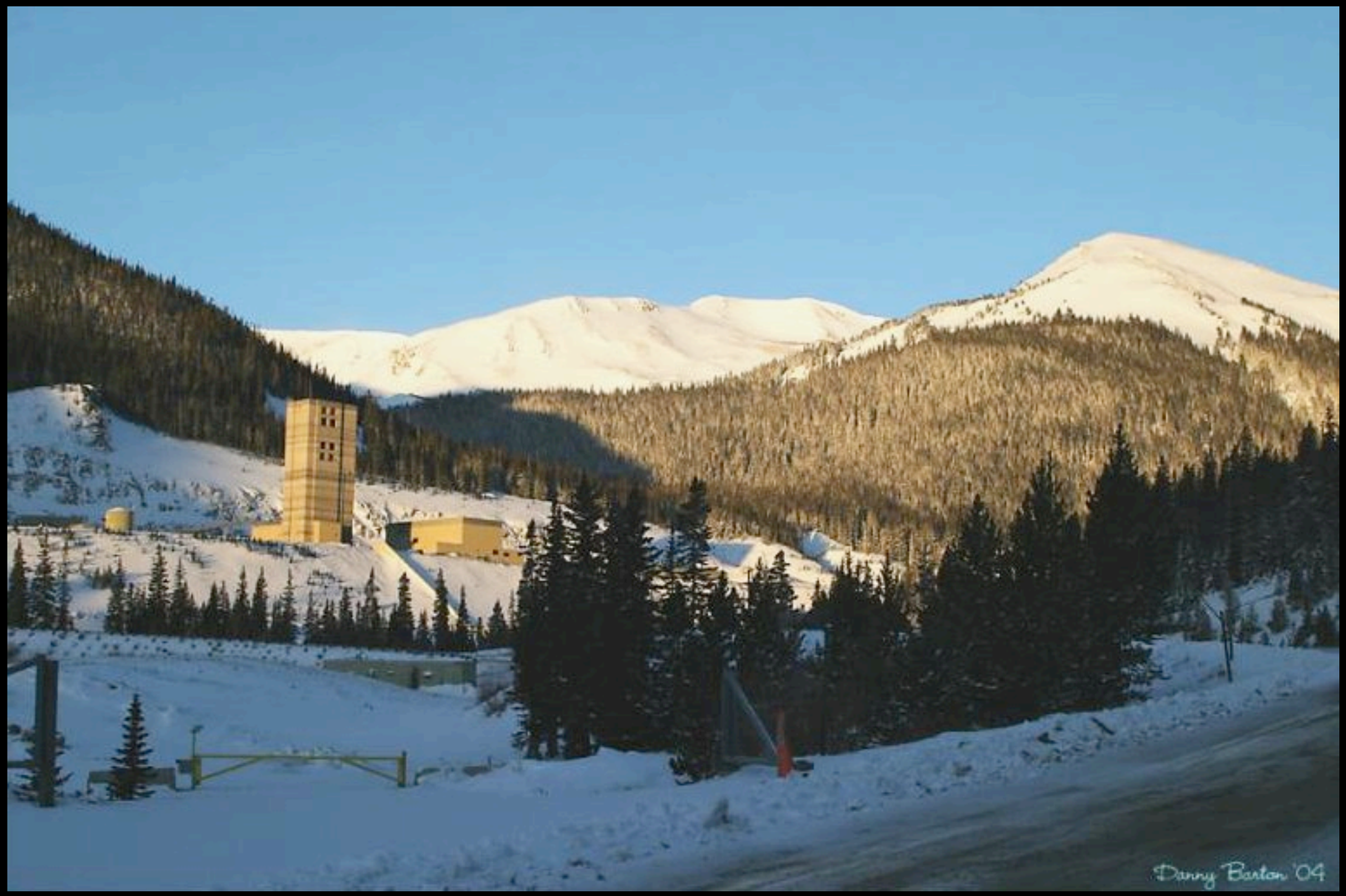

Oscillation baselines: FNAL 1500 km
BNL 2760 km

# Where is Henderson?

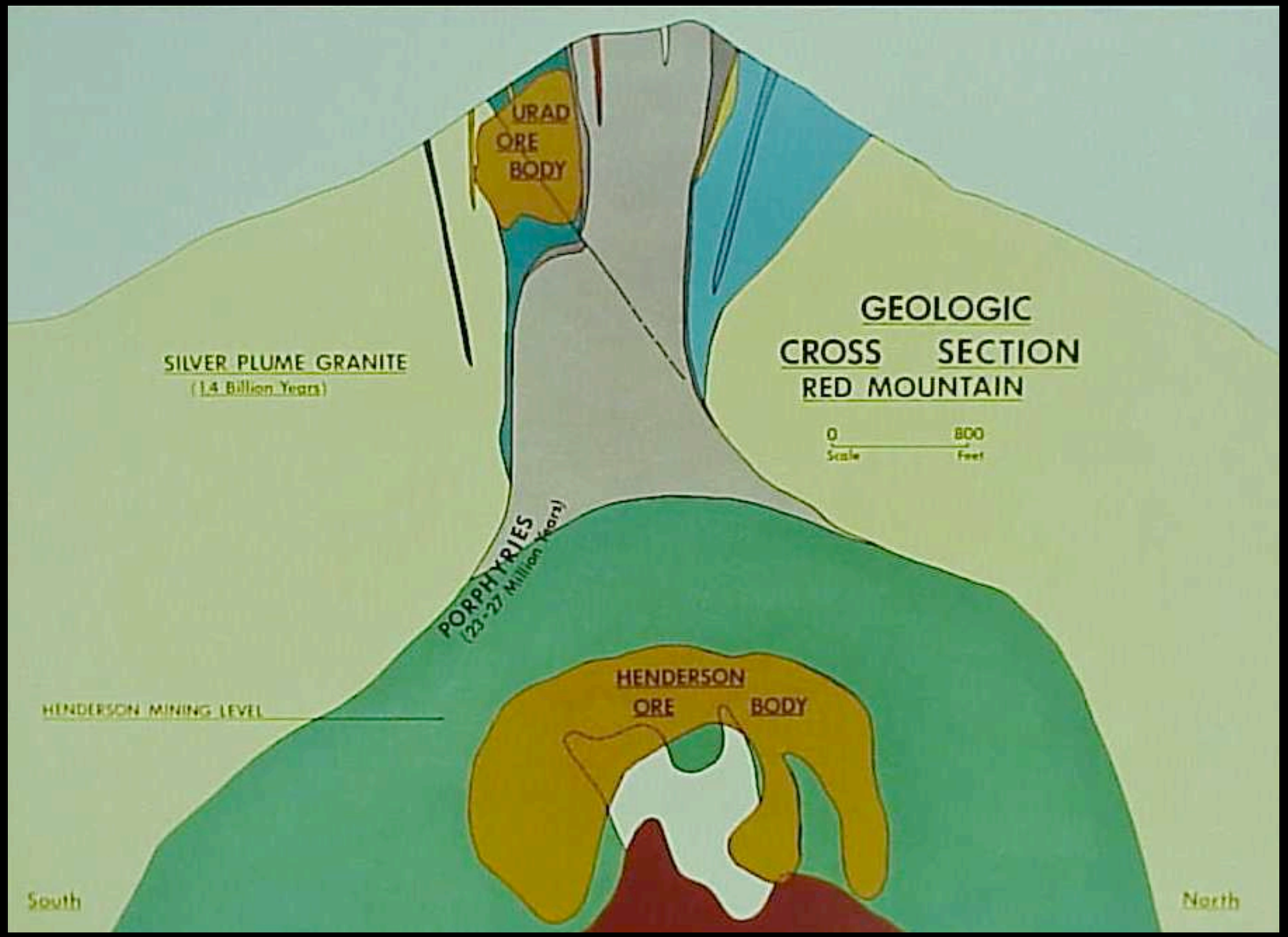
Here!


| | | | |
|---|---|---|---|
| 330 | LOS ALAMOS | DENVER | 50 |
| 19 | WINTER PARK | BOULDER | 55 |
| | | DENVER INT'L AIRPORT | 70 |

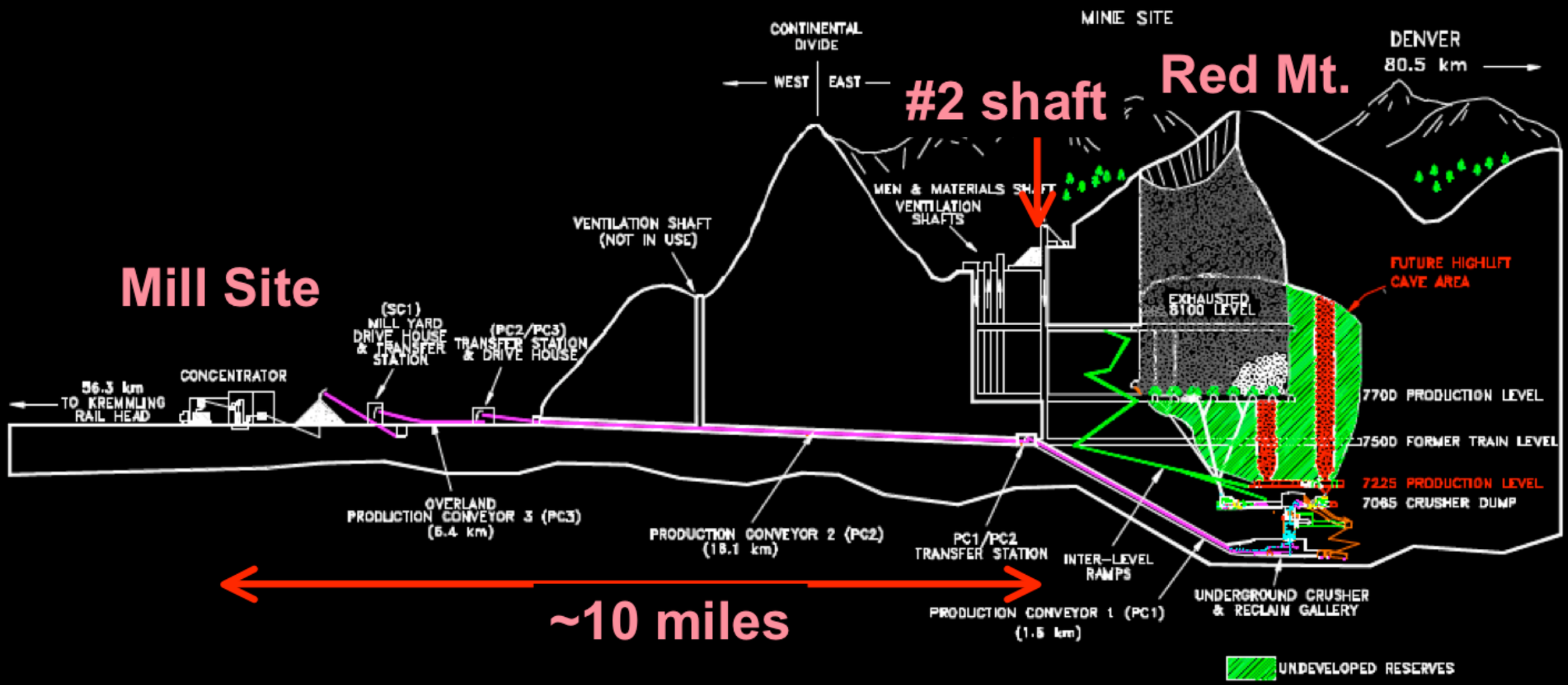
# The Mine Site



# The Geology


URAD
ORE
BODY
SILVER PLUME GRANITE
(1.4 Billion Years)
GEOLOGIC
CROSS SECTION
RED MOUNTAIN
0
800
Scale
Feet
PORPHYRIES
(23-27 Million Years)
HENDERSON
ORE BODY
HENDERSON MINING LEVEL
South
North

# The existing mine




- Underground crusher processes 80 tons in seconds
- Rock dropped onto high-speed conveyor to tailings site

# *Existing mine facilities*

- Access drifts accomodate six-seat vehicles
- Excavation Capacity: ~40,000 - 50,000 ton/day
  - Actual operation: ~20,000 - 30,000 ton/day: under-utilized capacity
- 10 mile tunnel with high speed conveyor to tailings site
  - Conveyor belt: 50kton/day max capacity, 20kton/day normal operation
- Moderate temperature - cool air available year round
- High capacity water and sewage treatment plant
- Electric power station: 2 x 24 MW – also underutilized
- Tailings site owned by mine company
  - existing permit allows the deposition of over 340Mton
- Large office building and warehouses; space for more surface buildings adjacent to existing ones – could build a real surface campus
- Anticipated mine closing in about 20 years
  - Mine Co. and local politicians see science as one possible way of retaining employment, revitalizing the area, etc

# *Engine room*

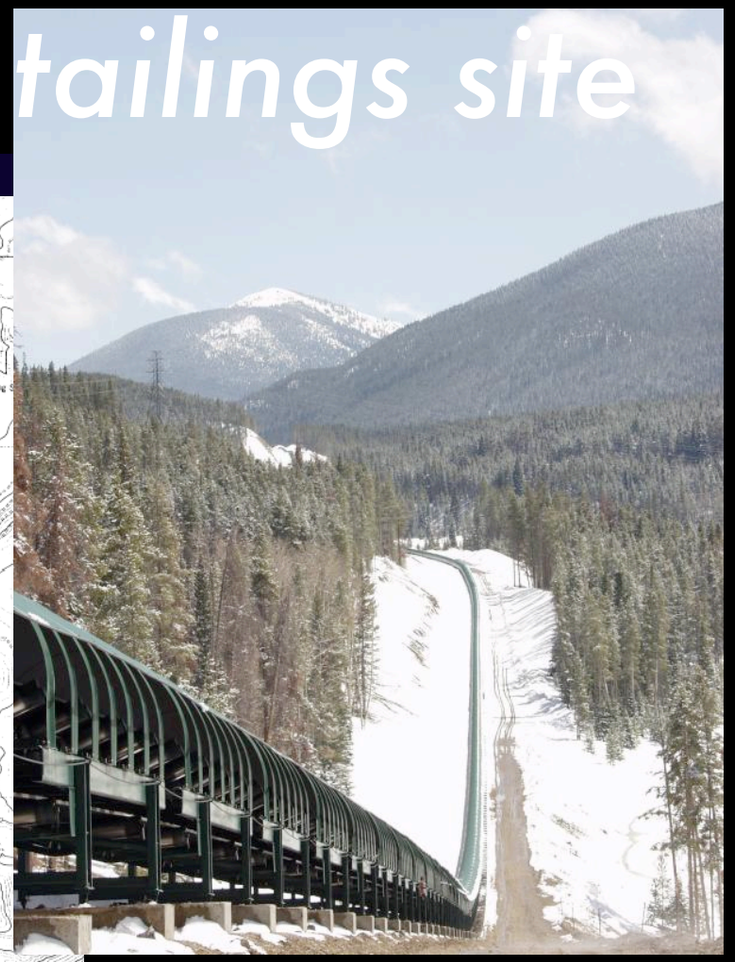
- 28-foot shaft can accomodate:
  - 200 people with 5-minute trip between surface (10,500) and 7500-foot level
  - 50 ton load
  - Standard shipping container

# *Feeding the rock crusher*

# *The crusher crushes*

# *Rock from crusher on the high-speed conveyor*

# Conveyor takes rock under Continental Divide to tailings site

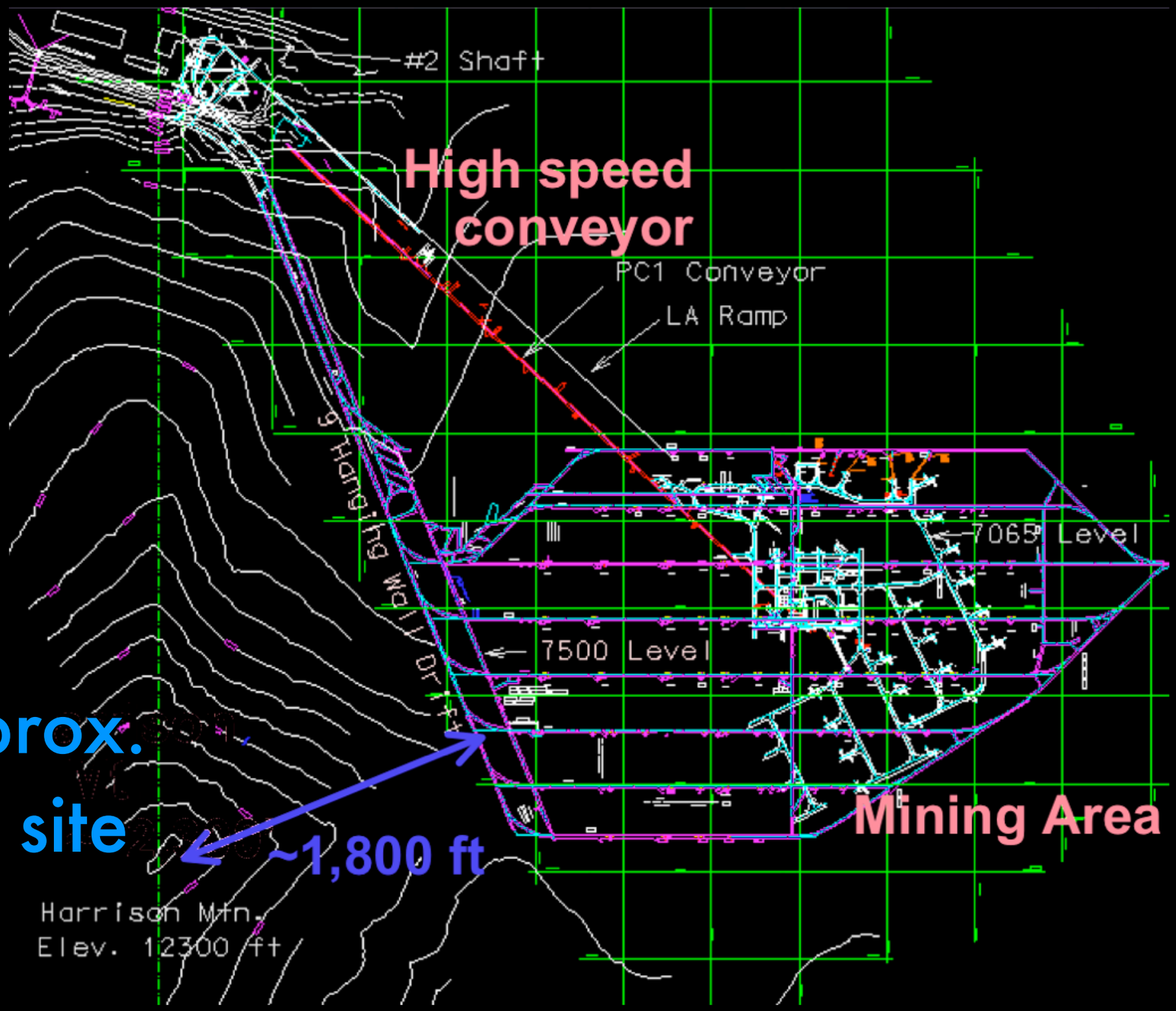



MAIN HENDERSON PROPERTY

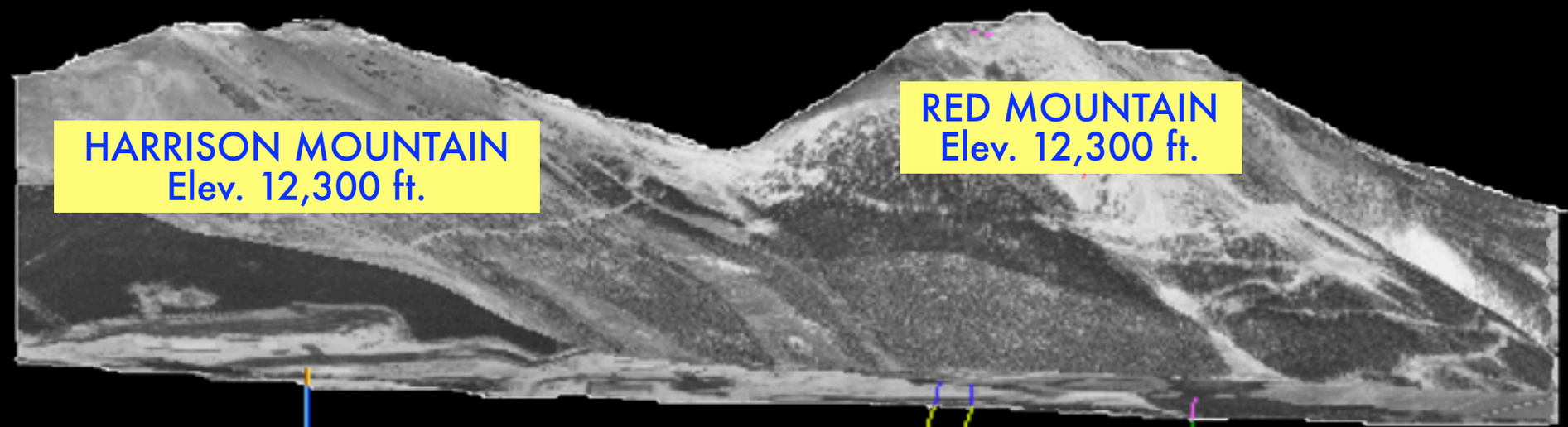
HIGH-SPEED CONVEYOR: 10 MILES

CONVEYOR TUNNEL COULD PROVIDE HORIZONTAL ACCESS AFTER MINING ENDS

# *Existing infrastructure and lab site: plan view*



# Proposed lab site




Shaft

*Silver Plume Granite*

*Red Mountain Porphyry*

*Silver Plume Granite*

perturbed rock

*Urad Porphyry*

**Upper Campus 1&2**
Elev. 8100 ft, (**2500 mwe**)
Elev. 7700 ft, (**3100 mwe**)

*Primos*

*Henderson Orebody*

pristine rock

*Porphyry*

7500 Level

7065 Level

**Central Campus**
Elev. 6750 ft, (**4200 mwe**)

*Henderson Granite*

Access Ramps

**EarthLab/ Geoscience Area**

**Midway Campus**
Elev. 5825 ft, (5100 mwe)

Internal Shaft

**Lower Campus**
Elev. 4900 ft. (**6000 mwe**)

Elevations in feet M.S.L.

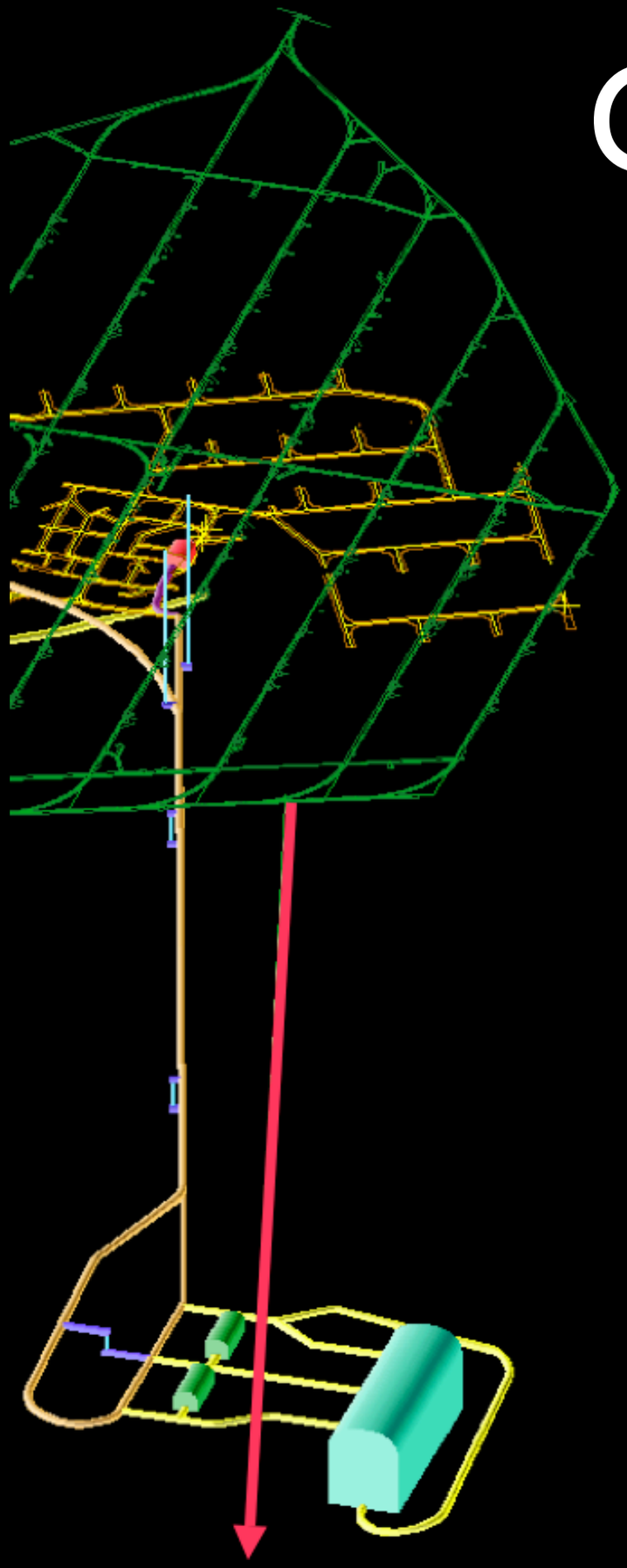
# *Upper Campus*

- Upper Campus (8100 level, 2500 mwe) is a 32,000 $ft^2$ former machine shop with crane access. Could be ready for experiments within months, at cost of about $100K.

- Other areas at 7500 and 7700 levels could be used too.

# *Central Campus*

- Second area of lab development: ~2 years
- Elevation 6750 ft (4200 mwe) level, accessed by new ramps from existing shaft area
- Central campus will have several large, multipurpose caverns (~20x20x100 $m^3$)
- Also natural location for future megaton-scale proton decay/neutrino detector cavern (shown in diagrams, but not part of DUSEL scope)



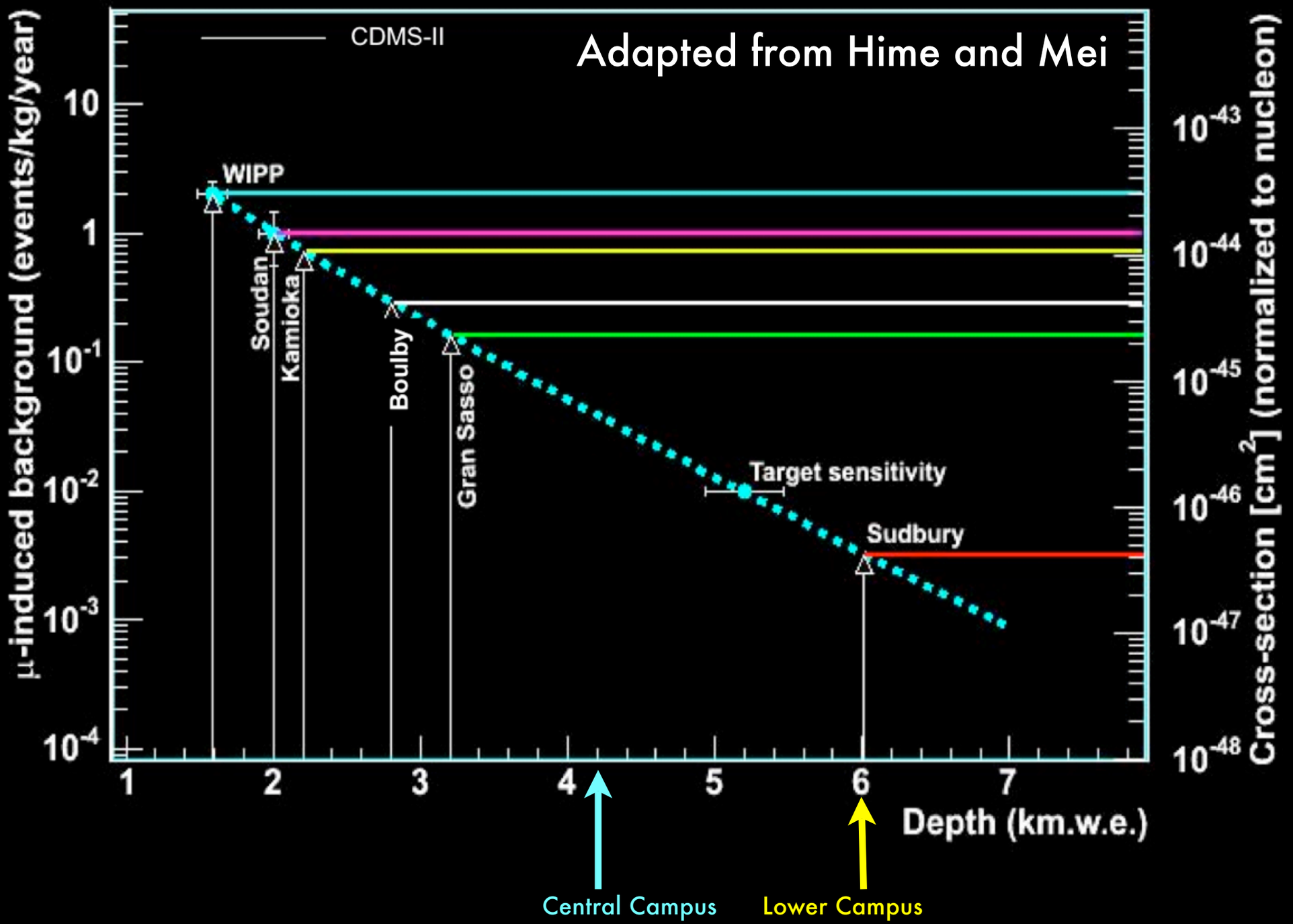
# Core drill to Central Campus site

- State of Colorado and participating universities funded an exploratory core drill to the proposed central campus site in 2004.
- 750 m long, inclination of 26 degrees, from top at 7,500' MSL to bottom at 6,300' (past Central Campus site)
- Results (good news):
  - Extremely competent Urad Porphyry (Granite)
  - Very hard with a high percentage of quartz.
  - Expected to have high compressive strength
  - No evidence of mineralization
    - Good news! Climax won't want to mine here.
    - No problem foreseen for constructing DUSEL

# *Lower Campus*

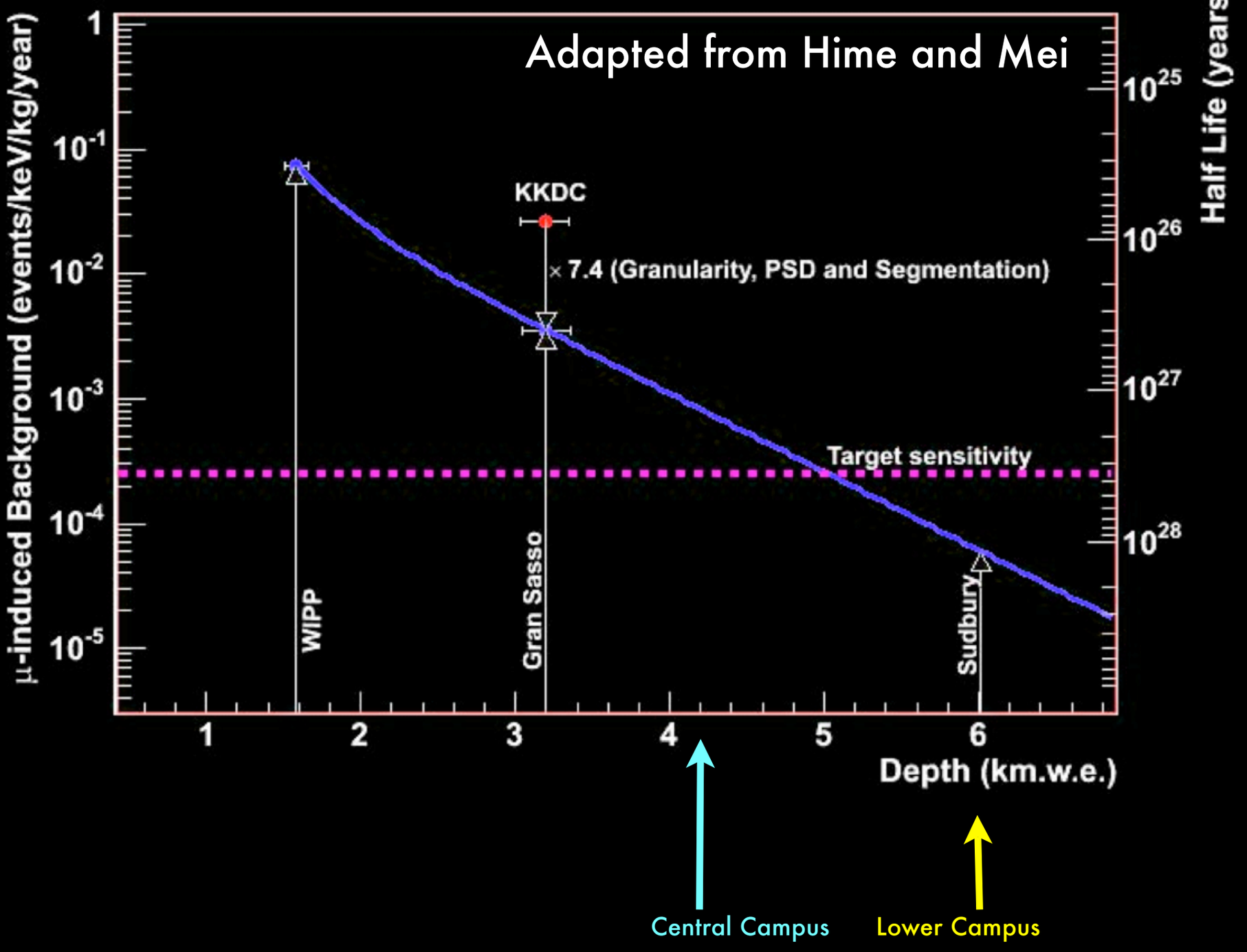
- Final area of lab development: ~5 years
- Elevation 4900 ft (6000 mwe), for lowest-background requirements
- Typical lower campus cavern size ~20x20x50 $m^3$
- Likely location for future phase of double-beta, dark matter, solar neutrino experiments
- Second core drill in planning stage, to reach lower campus site and confirm geology

# Dark matter sensitivity




Henderson

# *Neutrinoless double beta decay sensitivity*

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# *Henderson Lab organization*

- Henderson Underground Science and Engineering Project (HUSEP) Collaboration
  Spokesperson: C. K. Jung, Deputy Spokesperson: R. J. Wilson
  - The Arapaho Project (local community group)
  - Climax Molybdenum Company
  - Colorado School of Mines
  - Colorado State University
  - State University of New York at Stony Brook
  - University of Colorado at Boulder
- State of Colorado commission announced by Governor's executive order yesterday.

# *HUSEP Physics Committee*

- Chair R. J. Wilkes (Univ. of Washington)
- Co-chairs Dan Akerib (CWRU), EDZ
- Working groups:
  - Neutrino mass (solar, 0νββ)
    - Convenor: TBA (see me if interested)
  - Neutrino mixing
    - Convenors: W. Toki, C. Lunardini
  - Dark matter
    - Convenors: H. Nelson, L. Rosenberg
  - Nucleon decay
    - Convenors: M. Goodman, Tony Mann
  - Astrophysics
    - Convenors: A. Habig, T. Weiler

# *Workshop on physics at Henderson*

- November 18-19 (Fri.-Sat.) at Colorado State University in Fort Collins
- All are invited -- attendance does not imply any commitment
- Program and registration are at: http://hep45.hep.colostate.edu/~wilson/DUSEL/TopicalWorkshops/Physics-WorkshopNov05.html
- (or go to http://ale.physics.sunysb.edu/husep and click on "Conferences and Workshops")